

WHAT IS CLAIMED IS:

1. A metal extraction process comprising  
providing an ore containing a metallic element;  
reacting chlorine gas with the ore to form a chloride of the metallic element;  
mixing the chloride of the metallic element in an ionic liquid at a temperature from 0°C to 200°C to form an electrolyte;  
electrodepositing the metallic element from the electrolyte; and  
releasing a chlorine gas product from the electrolyte, wherein  
the chlorine gas reacting with the ore comprises at least a portion of the chlorine gas product.
2. The process according to Claim 1, further comprising dehydrating the ore before reacting the chlorine gas with the ore.
3. The process according to Claim 1, wherein the chlorine gas is reacted with the ore in a fluidized bed.
4. The process according to Claim 1,  
wherein the chloride of the metallic element is a gas;  
wherein the process further comprises condensing the gas to form a condensed metal chloride; and  
wherein the condensed metal chloride is mixed with the ionic liquid to form the electrolyte.
5. The process according to Claim 1, wherein the metallic element is selected from the group consisting of Li, Mg, Al, Ti, Zr and Nd.
6. The process according to Claim 1, wherein the metallic element is Al.
7. The process according to Claim 1, wherein the ore is bauxite.

8. The process according to Claim 1, wherein the ionic liquid comprises 1-butyl-3-methylimidazolium chloride.

9. The process according to Claim 1, wherein more than 80% of the chlorine gas reacting with the ore is the chlorine gas product.

10. A metal purification process comprising forming an anode from a material containing a metallic element; dissolving the anode in an electrolyte, comprising an ionic liquid containing a chloride of the metallic element, at a temperature of 0°C to 200°C; and electrodepositing the metallic element from the electrolyte on a cathode.

11. The process according to Claim 10, wherein the material comprises a metal alloy.

12. The process according to Claim 10, wherein the material comprises a metal matrix composite containing refractory particles in a metal matrix including the metallic element.

13. The processing according to Claim 12, wherein the refractory particles comprise at least one selected from the group consisting of SiC, Si<sub>3</sub>N<sub>4</sub>, AlN and Al<sub>2</sub>O<sub>3</sub>.

14. The process according to Claim 12, wherein the metal matrix comprises a metal alloy.

15. The process according to Claim 10, further comprising removing an undissolved portion of the anode from the electrolyte.

16. The process according to Claim 10, wherein the metallic element is selected from the group consisting of Li, Mg, Al, Ti, Zr and Nd.

17. The process according to Claim 10, wherein the metallic element is Al.

18. The process according to Claim 10, wherein the ionic liquid further comprises 1-butyl-3-methylimidazolium chloride.

19. The process according to Claim 10, wherein the chloride of the metallic element is  $\text{AlCl}_3$ .

20. The process according to Claim 10, further comprising removing impurities from the electrolyte.

21. The process according to Claim 10, wherein the cathode comprises the metallic element.

22. A metal purification process comprising  
providing a starting material containing a metallic element;  
dissolving the metallic element contained in the starting material in an electrolyte comprising an ionic liquid at a temperature from 0°C to 200°C; and  
electrodepositing the metallic element contained in the electrolyte on a cathode,  
wherein  
the ionic liquid comprises 1-butyl-3-methylimidazolium chloride.

23. The process according to Claim 22, wherein the starting material comprises a member selected from the group consisting of an ore containing the metallic element, an alloy containing the metallic element, and a composite comprising refractory particles in a metal matrix containing the metallic element.

24. The process according to Claim 22, wherein the metallic element is selected from the group consisting of Li, Mg, Al, Ti, Zr and Nd.

25. An electrolysis cell for refining or recycling a metallic element in an anode of the cell, the electrolysis cell comprising

    a cathode including a porous basket and electrically conductive particles held by the porous basket;

    an electrolyte including an ionic liquid containing a chloride of the metallic element;

and

    a container holding the cathode and the electrolyte.

26. The electrolysis cell according to Claim 25, wherein the porous basket comprises a material selected from the group consisting of Al, Cu and stainless steel.

27. The electrolysis cell according to Claim 25, wherein the electrically conductive particles comprise an element selected from Al and C.

28. The electrolysis cell according to Claim 25, wherein the ionic liquid further comprises 1-butyl-3-methylimidazolium chloride.

29. The electrolysis cell according to Claim 25, wherein the chloride of the metallic element comprises  $\text{AlCl}_3$ .